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THE ST. CLAIR RIVER

SPILL MANUAL

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RÉSUMÉ

Le guide intitulé *St. Clair River Spill Manual* permet d'effectuer, à certaines prises d'eau en aval, des évaluations rapides et simples de l'incidence des polluants déversés par des exutoires situés dans la "Zone de la chimie". En tout, on étudie 20 exutoires et quatre prises d'eau municipales. On évalue également l'incidence des déversements à deux endroits situés dans le cours inférieur de la rivière St. Clair. Les données à recueillir sont le genre de polluant déversé, la masse totale et la durée du déversement ainsi que le débit total de la rivière. Puis à l'aide du guide, on peut déterminer la valeur quantitative des plus fortes concentrations à la prise d'eau ainsi que le moment où les polluants déversés y parviennent, le moment où leur concentration y est maximale et le moment où ils disparaissent.

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FOREWORD

The St. Clair River Spill Manual was developed to provide relatively rapid and easy-to-use assessment techniques to predict the concentration of spilled contaminants at selected downstream water intakes.

A total of 21 outfalls located within the "Chemical Valley" are included in the Manual. These are the major outfall(s) of Esso Petroleum, Esso Chemical, Cole Drain, Polysar, Dow, Sun Oil, Talford Creek (for Shell Oil), Ethyl, Dupont, Petrosar, Novacor, C.I.L., and Murphy Drain (for Chinook Chemicals). Spill impacts from these outfalls can be assessed at the municipal water intakes of Wallaceburg and Walpole, Stag, and Fawn Islands. Spill impact information is also provided for the Lambton Generating Station intake and at the head of Chenal Ecarte, to permit assessments of impact along the Canadian shoreline of this portion of the St. Clair River. In addition, spill impact assessments are possible for the 5 Michigan intakes of St. Clair, East China Township, Marine City, Algonac, and Old Club.

The required input data for using the Manual include the type of spill contaminant, total mass spilled, the duration time of the spill, and an estimate of the total river flow rate at the time of the spill. If the decay characteristics of the contaminant are known, they may be incorporated into the analysis. (This information is provided for selected contaminants.)

The Manual is then used to provide a quantitative value of the peak contaminant concentration and its time of arrival at the selected water intake. It also provides the times of arrival and departure of the beginning and end of the spill-plume at the water intake, since due to river dispersion the plume spreads out as it travels downstream.

The results provided in the nine tables included in the Manual, were derived from the actual results of several past projects carried out by the Ministry of Environment. Two mathematical models [1, 2] were used in estimating the peak concentrations, depending upon the spill duration time. Both assume complete vertical mixing, which will occur by the time the plume reaches the specified water intakes. For spills with 'short' duration times (i.e. less than the critical spill duration time), both longitudinal and lateral dispersion will act upon the spilled contaminant

in reducing its peak concentration as it travels downstream. For 'long' duration spills, only lateral dispersion will effectively reduce the maximum concentration of the spilled contaminant.

The various travel times provided were derived via a series of steps. These include:

1. Field measurements of the pertinent travel times and dispersion characteristics, using the results of a study completed by the Ministry of the Environment in 1986.

2. Establishment of the vertically-averaged, 2-D flow field using the 'KE' hydrodynamic program provided via previous contract work [4].

3. Calculation of the pertinent river volumes and areas used in establishing the travel times, using the 'AVCAL' program, developed by the Ministry of the Environment [5].

Information on the river flow rates and stages was taken from various NOAA data [6, 7].

The dispersion coefficients required for use in the mathematical models may vary in value within defined ranges. For safety, the actual dispersion coefficients selected were such to assure that the predicted peak concentrations (Tables 8 and 9) are equal to or greater than the actual concentrations. This was accomplished by using dispersion coefficients in the low-range for the intakes 'along-shore' (i.e. Lambton G.S., Chenal Ecarte, Walpole Island, and Wallaceburg), and lateral dispersion coefficients in the high-range for the 'offshore' intakes (i.e. Stag and Fawn Islands, and the Michigan locations). However, the predicted-to-actual concentration ratios are not likely to exceed a value of about 3. Also for safety, no reduction in peak concentration between the head of Chenal Ecarte and the Wallaceburg intake is considered, even though preliminary analysis indicated that this was possible for spills of shorter duration.

For the 'off-shore' intakes, the lateral edge of the plume was assumed to lie 3.3 standard deviations from the peak location, (which corresponds to 99.9% of the area under the Normal Curve). This limit was imposed to

avoid unrealistic mathematical dispersion. The zero values in Tables VIII and IX represent intakes outside of the outfall's plume. The Marysville, Michigan intake was found to lie outside of all the plumes considered in the Manual and thus is not expected to be impacted by any spills from Ontario sources. As a result, the Marysville intake is not shown in the Manual's tables.

In general, the impact on the Michigan water supplies is significantly small as compared to the impact on the Ontario water supplies. For long duration spills from Ontario sources located upstream of Stag Island, the predicted concentration at the St. Clair, East China Township, Marine City, and Algonac intake, is about 2%, 1%, 2%, and 7%, respectively, of the predicted concentration at the Ontario shoreline of the same river location. These percentages will decrease, eventually, reaching values of zero, as the location of the source of the spill is moved farther downstream. Also, for any given source location along the Ontario shoreline, these percentages are predicted to be much smaller for a short duration spill, (i.e. for spill duration times less than the critical spill duration times for the Michigan intakes).

This manual will be updated as required to reflect future assessment requirements and research results.

SUMMARY OF PROCEDURE

The use of the St. Clair River Spill Manual is divided into two parts (I and II). These are the assembly of the necessary data associated with spill events and the assessment procedure to predict the impact on water uses.

A summary of the data required for spill assessment includes:

1. the name of the outfall from which the spill enters the river;
2. the name of the water intake(s) which the spill material may affect;
3. the contaminant of concern contained within the spilled material;
4. the spill duration time, (the length of time over which the spill occurred);
5. the total mass of the spilled contaminant;
6. the estimated total river flow rate at the time of the spill.

A chronological summary of the spill assessment procedure is as follows:

1. Determine the mean travel time;
2. Determine the critical spill duration time;
3. Determine the time between spill arrival and peak concentration;
4. Determine the contaminant-dependent, general decay factor;
5. Determine the numerical value of the general decay factor;

6. Comparison of the spill duration time to the critical spill duration time. When the spill duration time is smaller than the critical spill duration time, the following steps are used:

   (i) Determination of the 'no-decay' peak concentration for a unit spill mass;

   (ii) Calculation of the actual peak concentration, correcting for decay and actual spill mass;

   (iii) Calculation of the arrival time of the peak concentration at the intake;

   (iv) Calculation of the arrival time of the spill-plume at the water intake;

   (v) Calculation of the departure time of the spill-plume from the water intake;

7. A summarization statement of the spill assessment, as provided in Steps 1 through 6.

If the spill duration time is longer than the critical spill duration time (as compared in Step 6), then a different set of tables and equations are used. These, however, will provide the same information as obtained in Steps 6(i) through 7.

A "Spill Manual Work Sheet" is provided to permit rapid, easy to follow, and concise spill assessments, as the user follows the steps of Parts I and II.

An example spill impact assessment is also provided to illustrate the use of this manual.

DEFINITION OF SYMBOLS

The symbols used in the various tables and equations of the spill manual are defined as follows, in alphabetical order:

CEC = The spill-specific predicted peak-equilibrium concentration, in ug/L, (which has been corrected for both decay and the specific spill mass-rate). This represents the maximum expected concentration at the intake for a long-duration spill.

CO = The concentration of the spilled contaminant in the outfall's effluent, in Kg/m^3 (or g/L). This may be used in estimating the total spill mass.

CPC = The spill-specific predicted peak concentration, in ug/L, (which has been corrected for both decay-loss and the specific spill mass). This represents the maximum expected concentration at the intake for a short-duration spill.

DF1 to DF9 = The nine general decay factors which may be used in correcting the predicted concentrations for decay loss. These factors are for numerical decay rates of from 0 (conservative) to $128. \times 10^{-6}\ s^{-1}$.

EC = The predicted peak-equilibrium concentration, in ug/L, for a unit loading rate of 1 Kg/s, and no decay, used for the long-duration spill.

M = The total mass of the contaminant, in Kg, which exits the outfall during the spill duration time.

NUMDF = The fraction of the conservative contaminant's concentration remaining at the water intake, based upon the loss rate as provided by the general decay factor, and mean travel time from this outfall to the intake.

PC = The predicted peak-concentration, in ug/L, for a unit load of 1 Kg, and no decay, used for the short-duration spill.

QO = The discharge rate, in m^3/s, of the outfall's effluent which contains the spilled-contaminant. This may be used in estimating the total spill-contaminant mass.

T = The spill duration period, in hours, which is the elasped time from the start to end of the spill, (or a portion thereof to be analyzed).

TA = The arrival time to the intake, of the forward edge of the spill-plume, measured in hours after the start of the spill.

TAPD = The length of time between the arrival of the forward edge of the spill-plume and the arrival of the peak concentration, at the intake, in hours.

TC = The critical spill duration in time, in hours. When the actual spill duration time is shorter than the critical spill duration time, then it is a 'short-duration spill' and vice-versa for a 'long-duration spill'.

TD = The departure time from the intake, of the trailing edge of the spill-plume, as measured in hours after the start of the spill.

TPK = The arrival time at the intake, of the expected peak concentration for a short-duration spill, as measured in hours after the start of the spill.

TPKB = The beginning time at the intake of the peak-equilibrium concentration for a long-duration spill, as measured in hours after the start of the spill.

TPKE = The ending time at the intake of the peak-equilibrium concentration for a long-duration spill, as measured in hours after the start of the spill.

TT = The mean travel time, in hours. This is the time required, on average, for the plume to travel from the outfall to intake.

THE MANUAL

PART I: NECESSARY INFORMATION FOR USING THE SPILL MANUAL

1. Outfall/Intake Identification:

a) Name of the outfall from which the spill entered the river. The outfalls included in the manual are provided in Table I. Their locations are shown in Figures 1, 2, 3, 5 and 7.

If the outfall is not included in Table I, then:

i) using the Figures, select the outfall from Table I of similar type (shore based or extended), immediately downstream of the actual outfall location. As a guide, the maximum distance between the actual outfall location and that used from Table I, should not exceed 500 and 1000 feet (150 and 300 m), for shore based and extended outfalls, respectively.

ii) if i) is not possible, then repeat the Spill Manual Procedure (Part II) for two outfalls of similar type, (one upstream and one downstream), and interpolate the results.

b) Name of the water intake where spilled-contaminant concentrations and passage times are to be determined. The intakes included in the manual are provided in Table II. Their locations are shown in Figures 3 through 10.

2. Spill Characteristics:

a) The spill-contaminant of concern (e.g. benzene, carbon tetrachloride, etc.).

b) The total spill duration time period. This is the elapsed time from the start to end of the spill, (or a portion thereof, of particular concern). This time is designated with a "T" symbol, and is in units of hours, for calculations in this manual.

c) The total mass of the contaminant which exits the outfall during the spill duration time period. This mass is designated with a "M" symbol, and is measured in units of Kg for calculations in the manual. "M" may be calculated using the following formula:

$$M \text{ (in Kg)} = QO \text{ (in } m^3/s) * CO \text{ (in Kg}/m^3) * T \text{ (in hrs)} * 3600. \text{ (s/hr)}.$$

where: QO = the discharge rate of the outfall's effluent which contains the spilled contaminant.

CO = the concentration of the spilled contaminant in the outfall's effluent.

T = the spill duration time period.

3. Total River Flow Rate:

The total river flow rate, during the spill and subsequent travel period, should be known. If a concurrent estimate is not possible, then an approximate value, such as the most recent monthly mean flow rate should be used. (For use in this manual, the river flow rate should be in units of ft^3/s).

The results in this manual are presented for both 'long-term average' and 'near maximum' St. Clair River flow rates. If the actual rate is not near these two values, then both cases should be checked with either the interpolated or worse-case results chosen.

PART II: SPILL IMPACT ASSESSMENT PROCEDURE

Having obtained estimates for all the information as outlined in Part I, the following procedure should be used to assess the impact of the spill upon the water intake.

1. Using Table III, obtain "TT", the mean travel time in hours, by:

   a) moving down the two left-hand columns, select the correct outfall and total river discharge rate; and

   b) then move to the right, to the correct water intake column.

2. Using Table IV, obtain "TC", the critical spill duration time, in hours (following the same procedure as in Step #1).

3. Using Table V, obtain "TAPD", the time between arrival and peak, or peak and departure, in hours (following the same procedure as in Step #1).

4. Using Table VI, obtain the correct general decay factor, "DF1", ..., "DF9", depending upon the type of spilled contaminant.

   If the contaminant is not listed in Table VI, then proceed as follows:

   a) If a decay rate (measured in s^{-1} units) is known or may be estimated with confidence, then assign the nearest general decay factor whose numerical decay rate is equal to or less than the contaminant's known decay rate. The numerical decay rates for the general decay factors are:

      DF1 = $0. \times 10^{-6}\ s^{-1}$ (DF1 = <u>no</u> decay)
      DF2 = $1. \times 10^{-6}\ s^{-1}$
      DF3 = $2. \times 10^{-6}\ s^{-1}$
      DF4 = $4. \times 10^{-6}\ s^{-1}$
      DF5 = $8. \times 10^{-6}\ s^{-1}$
      DF6 = $16. \times 10^{-6}\ s^{-1}$
      DF7 = $32. \times 10^{-6}\ s^{-1}$
      DF8 = $64. \times 10^{-6}\ s^{-1}$
      DF9 = $128. \times 10^{-6}\ s^{-1}$

b) If the decay rate of the contaminant is not known or is uncertain, then assume "DF1", which is the no decay or 'conservative' condition. (This will result in the 'largest possible' predicted contaminant concentrations downstream at the water intakes).

5. Using Table VII, obtain "NUMDF", the fraction of contaminant concentration remaining, for the general decay factor selected in Step #4 ("DF1", ..."DF9"), using the appropriate mean travel time, "TT", between the outfall and water intake, as obtained in Step #1.

6. Compare the total spill duration time "T", with the critical spill duration time "TC".

   a) If: T < TC, follow the procedure outlined in Steps #7 to 12;

   b) If: T > TC, follow the procedure outlined in Steps #13 to 19.

Steps #7 to 12 are for T < TC only:

7. Using Table VIII, obtain "PC" the predicted no-decay peak concentration, in ug/L, (using the correct outfall/intake combination and total river flow rate), for a 1 Kg. load.

8. Calculate "CPC" which is the spill specific predicted peak concentration, in ug/L, (corrected for both the specific spill mass "M", and for decay via "NUMDF"). Use the following equation:

$$CPC = M * PC * NUMDF$$

where: M is defined in Part I - Step #2 c), in Kg
PC is obtained in Step #7
NUMDF is obtained in Step #5

9. Calculate "TPK" the arrival time at the intake of the decay-corrected peak concentration, as measured in hours after the start of the spill. Use the following equation:

TPK = T/2 + TT

where: T is defined in Part I - Step #2 b)
TT is obtained in Step #1

10. Calculate "TA", the arrival time at the intake of the spill plume, measured in hours after the start of the spill. At this time, the spill plume is beginning to arrive at the intake, with the contaminant concentration less than about 1/20 of the calculated "CPC" of Step #8. Use the following equation:

TA = TT - TAPD + T/2

where: TT is obtained in Step #1
TAPD is obtained in Step #3
T is defined in Part I - Step #2 b)

11. Calculate "TD", the departure time at the intake of the spill plume, measured in hours after the start of the spill. At this time, the spill plume has largely passed by the intake, with the contaminant concentration less than about 1/20 of the calculated "CPC" of Step #8. Use the following equation:

TD = TT + TAPD + T/2

where: TT is obtained in Step #1
TAPD is obtained in Step #3
T is defined in Part I - Step #2 b)

12. To summarize the results for T < TC:

The arrival, peak, and departure times of the spill plume at the water intake occur "TA", "TPK", and "TD" hours, respectively, after the start of the spill. At these times, the spill-contaminant concentration expected is about "CPC/20", "CPC", and "CPC/20" ug/L, respectively.

The time in hours required for the spill plume to pass the water intake, is equal to the difference in arrival and departure times ("TD-TA").

<u>Steps #13 to 19 are for T > TC only</u>:

13. Using Table IX, obtain "EC", the predicted no-decay peak-equilibrium concentration, in ug/L, (using the correct outfall/intake combination and total river flow rate), for a loading rate of 1 Kg/s.

14. Calculate "CEC", which is the spill specific predicted peak-equilibrium concentration, in ug/L, (corrected for both the specific spill mass rate "M/T", and for decay via "NUMDF"). Use the following equation:

$$CEC = \frac{(M * EC * NUMDF)}{(T * 3600.)}$$

where: M is defined in Part I - Step #2 c), <u>in Kg</u>
T is defined in Part I - Step #2 b), <u>in hrs</u>
EC is obtained in Step #13
NUMDF is obtained in Step #5

15. Calculate "TPKB", the beginning time of the decay-corrected peak-equilibrium concentration at the intake, measured in hours after the start of the spill. Use the following equation:

TPKB = TT + TC/2

where: TT is obtained in Step #1
TC is obtained in Step #2

16. Calculate "TPKE", the ending time of the decay-corrected peak-equilibrium concentration at the intake, measured in hours after the start of the spill. Use the following equation:

TPKE = TT + T - TC/2

where: TT is obtained in Step #1
TC is obtained in Step #2
T is defined in Part I - Step 2 b)

17. Calculate "TA", the arrival time at the intake of the spill plume, measured in hours after the start of the spill. At this time, the spill-plume is beginning to arrive at the intake, with the contaminant concentration less than about 1/20 of the calculated "CEC" of Step #14. Use the following equation:

TA = TT - TAPD

where: TT is obtained in Step #1
TAPD is obtained in Step #3

18. Calculate "TD", the departure time at the intake of the spill plume, measured in hours after the start of the spill. At this time, the spill plume has largely passed by the intake, with the contaminant concentration less than about 1/20 of the calculated "CEC" of Step #14. Use the following equation:

TD = TT + T + TAPD

where: TT is obtained in Step #1
TAPD is obtained in Step #3
T is defined in Part I - Step 2 b)

19. To summarize the results for T > TC:

The arrival and departure times of the spill-plume at the intake occur "TA" and "TD" hours, respectively, after the start of the spill. At these times, the spill-contaminant concentration is about "CEC/20".

The time in hours required for the plume to pass the intake, is equal to the difference in arrival and departure times, ("TD-TA").

From "TPKB" to "TPKE" hours after the start of the spill, the peak-equilibrium spill-contaminant concentration of "CEC" ug/L will exist at the intake.

EXAMPLE SPILL IMPACT ASSESSMENT

Spill Information Provided by Company:

A spill of 1,2-dichloroethane lasted for 2 hours, starting around 3 p.m., on February 28. The spill exited to the river via the 42-inch sewer at First Street. The estimated discharge rate in the sewer is 13. mgd. Estimated mixed concentrations in the sewer of 1,2-dichloroethane are: 193, 145, 62, 4.4, and 0.8 ppm. These are for every half-hour (beginning at the start of the spill).

Problem:

Determine the impact of this spill upon the Walpole Island and Wallaceburg Water Intakes.

Solution:

The assessment is summarized in the following "Spill Manual Work Sheets". The first is for Walpole Island, the second is for Wallaceburg. Some points to be made, in chronological order filling-out the sheets, are as follows:

For both assessments:

(i) Use equation of Step 2c) of Part I to estimate "M":

$$QO = 13 \text{ mgd} = 24.2 \text{ ft}^3/\text{s} = 0.684 \text{ m}^3/\text{s}$$

$$CO = \frac{193 + 145 + 62 + 4.4 + 0.8}{5} = 81.0 \text{ ppm } \frac{\text{mg}}{\text{L}}$$

$$= 0.081 \text{ Kg/m}^3$$

$$\therefore \; M = 0.684 \; \frac{\text{m}^3}{\text{s}} * .081 \; \frac{\text{Kg}}{\text{m}^3} * 2. \text{ hr} * 3600. \; \frac{\text{S}}{\text{hr}}$$

$$= 399. \text{ Kg.}$$

ii) No concurrent estimate of the total St. Clair River is available, ∴ use as a guide, the January mean monthly value of 196,000 cfs. Since this is close to 187,000 cfs, (as compared with 240,000 cfs), use the 187,000 cfs condition for the assessment.

iii) For both assessments (Walpole Island and Wallaceburg) T>TC, therefore Steps #13 through 19 are used.

Assessment Summary for Walpole Island:

° The arrival and departure times of the spill-plume at the intake occur 12.1 to 19.3 hours after the start of the spill, (∴ from about 3:00 a.m. to 10:30 a.m. on March 1).

° From 15.2 to 16.2 hours after the start of the spill (from about 6:00 a.m. to 7:00 a.m. on March 1), the peak-equilibrium concentration of about 38 ug/L will exist at the intake.

(For interest sake only, the measured concentration at Walpole Island was 24.5 ug/L at 6:00 a.m. on March 1, 1986).

Assessment Summary for Wallaceburg:

° The arrival and departure times of the spill-plume at the intake occur 15.3 to 31.3 hours after the start of the spill (from about 6:30 a.m. to 10:30 p.m. on March 1).

° From 22.8 to 23.8 hours after the start of the spill (from about 1:30 p.m. to 3:00 p.m. on March 1), the peak-equilibrium concentration of about 37 ug/L will exist at the intake.

SPILL MANUAL WORK SHEET

(Following the steps of Parts I and II, the results may be recorded on this sheet

SPILL IDENTIFICATION: Impact upon Walpole Island intake of:
February 28, 1986 spill of 1,2-dichloroethane

PART I - INPUT DATA PREPARATION:

1.(a)	Outfall name:	Dow 1st Street		(Table I)
(b)	Water intake name:	Walpole Island		(Table II)
2.(a)	Spill contaminant name:	1,2-dichloroethane		
(b)	Spill duration time:	T = 2.0	hr	
(c)	Spill contaminant mass:	M = 399.	Kg	
3.	Total river flow rate	(use) = 187,000	cfs	

PART II - SPILL IMPACT ASSESSMENT PROCEDURE:

1. TT = 14.7 hr (Table III)
2. TC = 1.03 hr (Table IV)
3. TAPD = 2.6 hr (Table V)
4. DF 3 (Table VI)
5. NUMDF = 0.904 (Table VII)
6. Compare: T and TC : (2.0 > 1.03)

For T < TC, only:

7. PC = ug/L (Table VIII)
8. CPC = ug/L
9. TPK = hr
10. TA = hr
11. TD = hr
12. Summarize assessment:

At time after spill start		Expected Conc.	
TA =	hr,	<CPC/20<	ug/L
TPK =	hr,	= CPC =	ug/L
TD =	hr,	<CPC/20<	ug/L

Time of Passage = TD-TA = hr

For T > TC, only:

13. EC = 762. ug/L (Table IX)
14. CEC = $\frac{(399 * 762 * .904)}{(2.0 * 3600)}$ ug/L
    = 38. ug/L
15. TPKB = 14.7 + (1.03/2) = 15.2 hr
16. TPKE = 14.7+2.0-(1.03/2) = 16.2 hr
17. TA = 14.7-2.6 = 12.1 hr
18. TD = 14.7+2+2.6 = 19.3 hr
19. Summarize assessment:

At time after spill start	Expected Conc.		
TA = 12.1 hr,	<CEC/20<	2.	ug/L
TPKB = 15.2 hr	between these times		
TPKE = 16.2 hr	= CEC =	38.	ug/L
TD = 19.3 hr,	<CEC/20<	2.	ug/L

Time of Passage = TD-TA = 7.2 hr

SPILL MANUAL WORK SHEET

(Following the steps of Parts I and II, the results may be recorded on this sheet.

SPILL IDENTIFICATION: Impact upon Wallaceburg intake of:
February 28, 1986 spill of 1,2-dichloroethane

PART I - INPUT DATA PREPARATION:

1.(a)	Outfall name:	Dow 1st Street	(Table I)
(b)	Water intake name:	Wallaceburg	(Table II)
2.(a)	Spill contaminant name:	1,2-dichloroethane	
(b)	Spill duration time:	T = 2.0 hr	
(c)	Spill contaminant mass:	M = 399. Kg	
3.	Total river flow rate	(use) = 187,000 cfs	

PART II - SPILL IMPACT ASSESSMENT PROCEDURE:

1. TT = 22.3 hr (Table III)
2. TC = 0.93 hr (Table IV)
3. TAPD = 7.0 hr (Table V)
4. DF 3 (Table VI)
5. NUMDF = 0.854 (Table VII)
6. Compare: T and TC : (2.0 > 0.93)

For T < TC, only:

7. PC = ug/L (Table VIII)
8. CPC = ug/L
9. TPK = hr

10. TA = hr
11. TD = hr
12. Summarize assessment:

At time after spill start	Expected Conc.	
TA = hr,	<CPC/20<	ug/L
TPK = hr,	= CPC =	ug/L
TD = hr,	<CPC/20<	ug/L
Time of Passage = TD-TA =		hr

For T > TC, only:

13. EC = 777. ug/L (Table IX)
14. CEC = $\frac{(399 * 777 * .854)}{(2.0 * 3600)}$ = 37. ug/L

15. TPKB = 22.3 + (.93/2) = 22.8 hr
16. TPKE = 22.3+2.0-(.93/2) = 23.8 hr
17. TA = 22.3-7.0 = 15.3 hr
18. TD = 22.3+2+7.0 = 31.3 hr
19. Summarize assessment:

At time after spill start	Expected Conc.		
TA = 15.3 hr,	<CEC/20<	2.	ug/L
TPKB = 22.8 hr	between these times		
TPKE = 23.8 hr	= CEC =	37.	ug/L
TD = 31.3 hr,	<CEC/20<	2.	ug/L
Time of Passage = TD-TA =		16.0	hr

APPENDIX I:

TABLES FOR THE

ST. CLAIR RIVER SPILL MANUAL

TABLE I - OUTFALLS INCLUDED IN SPILL MANUAL

Outfall No.	Outfall Description (Company - Outfall Name - lateral location)	Distance from River-head to Outfall, (measured along the Centre of the River) (ft)
1	Esso Petro. - #3 Separator - shore	16,100
2	Esso Petro. - Impounding Basin - extended	18,300
3	Esso Petro. - #9 Separator - shore	20,000
4	Esso Chem. - # 11/12 Separator - extended	20,400
5	Cole Drain - extended	22,000
6	Polysar - 54" - shore	22,500
7	Polysar - Stereo - shore	23,200
8	Polysar - 66" - shore	23,500
9	Polysar - 72" - shore	23,600
10	Dow - 1st Street Outfall - shore	23,900
11	Dow - 2nd Street - extended	24,800
12	Dow - 3rd Street - shore	25,700
13	Dow - 4th Street - shore	26,600
14	Sun Oil - final - shore	30,000
15	Talford Ck - (Shell Oil) - shore	41,200
16	Ethyl - - extended	42,600
17	Dupont - shore	44,400
18	Petrosar - extended diffuser	45,600
19	Novacor - extended	57,500
20	CIL - shore	94,300
21	Murphy Drain- (Chinook Chemicals) - shore	120,500

TABLE II - INTAKES INCLUDED IN THE SPILL MANUAL

Intake No.	Intake Description (Municipality/Company)	Distance from River-head to Intake, (measured along the Centre of the River) (ft)
1	Lambton Generating Station	82,200
2	Head of Chenal Ecarte (Location)	141,000
3	Walpole Island	151,100
4	Wallaceburg	182,000
5	Stag Island	47,000
6	Fawn Island	118,300
7	St. Clair, Michigan	70,800
8	East China Twp., Michigan	96,900
9	Marine City, Michigan	112,000
10	Algonac, Michigan	149,900
11	Old Club, Michigan	207,500

TABLE III - VALUES OF "TT", THE MEAN TRAVEL TIME, IN HOURS

FROM OUTFALL	Total River Discharge CFS/1000	TO		INTAKE	
		Lambton Gen. Station	Head of Chenal Ecarte	Walpole Island	Wallaceburg
Esso Petroleum #3 Separator	240 187	6.2 7.1	12.0 13.8	13.4 15.4	20.3 23.1
Esso Petroleum Impounding Basin	240 187	5.4 6.1	11.2 12.9	12.6 14.5	19.5 22.1
Esso Petroleum #9 Separator	240 187	5.8 6.7	11.6 13.4	13.0 15.1	19.9 22.6
Esso Chemical #11/12 Separator	240 187	5.2 5.9	11.0 12.6	12.4 14.3	19.3 21.9
Cole Drain	240 187	5.1 5.8	10.9 12.5	12.3 14.1	19.2 21.7
Polysar - 54"	240 187	5.6 6.5	11.4 13.2	12.8 14.9	19.7 22.4
Polysar - Stereo	240 187	5.6 6.4	11.4 13.1	12.8 14.8	19.7 22.4
Polysar - 66"	240 187	5.5 6.4	11.4 13.1	12.7 14.8	19.7 22.3
Polysar - 72"	240 187	5.5 6.4	11.4 13.1	12.7 14.7	19.7 22.3
Dow - 1st Street	240 187	5.5 6.3	11.3 13.1	12.7 14.7	19.6 22.3
Dow - 2nd Street	240 187	5.2 6.0	11.1 12.8	12.4 14.4	19.4 22.0
Dow - 3rd Street	240 187	5.3 6.1	11.2 12.9	12.5 14.5	19.5 22.1
Dow - 4th Street	240 187	5.3 6.1	11.1 12.8	12.5 14.4	19.4 22.0
Sun Oil - final	240 187	5.0 5.7	10.8 12.4	12.2 14.1	19.1 21.7
Talford Creek	240 187	3.9 4.5	9.8 11.3	11.1 12.9	18.1 20.5
Ethyl	240 187	3.6 4.1	9.4 10.9	10.8 12.4	17.7 20.1
Dupont	240 187	3.5 4.1	9.4 10.8	10.7 12.4	17.7 20.0
Petrosar	240 187	3.3 3.8	9.1 10.5	10.5 12.2	17.4 19.8
Novacor	240 187	2.4 2.7	8.2 9.4	9.6 11.1	16.5 18.7
C.I.L.	240 187	- -	6.8 8.0	8.2 9.7	15.1 17.2
Murphy Drain	240 187	- -	2.4 2.9	3.8 4.6	10.7 12.2

TABLE III - VALUES OF "TT", THE MEAN TRAVEL TIME, IN HOURS (cont'd)

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE Stag Island	TO INTAKE Fawn Island
Esso Petroleum #3 Separator	240 187	2.9 3.3	9.9 11.3
Esso Petroleum Impounding Basin	240 187	2.2 2.5	9.1 10.2
Esso Petroleum #9 Separator	240 187	2.5 2.9	9.5 10.9
Esso Chemical #11/12 Separator	240 187	2.0 2.3	8.9 10.1
Cole Drain	240 187	1.9 2.2	8.8 9.9
Polysar - 54"	240 187	2.4 2.7	9.3 10.7
Polysar - Stereo	240 187	2.4 2.7	9.3 10.6
Polysar - 66"	240 187	2.3 2.6	9.2 10.6
Polysar - 72"	240 187	2.3 2.6	9.2 10.6
Dow - 1st Street	240 187	2.3 2.6	9.2 10.5
Dow - 2nd Street	240 187	2.0 2.2	8.8 10.0
Dow - 3rd Street	240 187	2.1 2.4	9.0 10.3
Dow - 4th Street	240 187	2.0 2.3	9.0 10.2
Sun Oil - final	240 187	1.7 2.0	8.7 9.9
Talford Creek	240 187	0.7 0.7	7.6 8.6
Ethyl	240 187	0.5 0.5	7.3 8.3
Dupont	240 187	0.3 0.3	7.2 8.2
Petrosar	240 187	0.1 0.2	7.0 7.9
Novacor	240 187	- -	5.9 6.7
C.I.L.	240 187	- -	4.2 4.8

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TABLE III - VALUES OF "TT", THE MEAN TRAVEL TIME, IN HOURS (To Michigan Intakes) (cont'd)

FROM OUTFALL	Total River Discharge CFS/1000	TO		INTAKE		
		St. Clair	East China Township	Marine City	Algonac	Old Club
Esso Petroleum #3 Separator	240	4.3	6.2	7.6	11.0	19.7
	187	5.0	7.2	8.9	12.8	23.0
Esso Petroleum Impounding Basin	240	4.2	6.0	7.5	10.9	19.6
	187	4.8	7.0	8.7	12.7	22.8
Esso Petroleum #9 Separator	240	4.0	5.9	7.4	10.8	19.4
	187	4.7	6.9	8.6	12.5	22.7
Esso Chemical #11/12 Separator	240	4.0	5.9	7.4	10.8	19.4
	187	4.7	6.9	8.6	12.5	22.7
Cole Drain	240	3.9	5.8	7.3	10.7	19.3
	187	4.6	6.8	8.5	12.4	22.6
Polysar - 54"	240	3.9	5.8	7.2	10.6	19.3
	187	4.5	6.7	8.4	12.4	22.5
Polysar - Stereo	240	3.9	5.7	7.2	10.6	19.3
	187	4.5	6.7	8.4	12.3	22.5
Polysar - 66"	240	3.8	5.7	7.2	10.6	19.2
	187	4.5	6.7	8.3	12.3	22.5
Polysar - 72"	240	3.8	5.7	7.1	10.6	19.2
	187	4.5	6.7	8.3	12.3	22.5
Dow - 1st Street	240	3.8	5.7	7.1	10.5	19.2
	187	4.4	6.6	8.3	12.3	22.4
Dow - 2nd Street	240	3.8	5.6	7.1	10.5	19.2
	187	4.4	6.6	8.2	12.2	22.4
Dow - 3rd Street	240	3.7	5.6	7.0	10.4	19.1
	187	4.3	6.5	8.2	12.1	22.3
Dow - 4th Street	240	3.6	5.5	6.9	10.4	19.0
	187	4.2	6.4	8.1	12.1	22.2
Sun Oil - final	240	3.4	5.3	6.7	10.1	18.8
	187	3.9	6.2	7.8	11.8	21.9
Talford Creek	240	2.6	4.5	5.9	9.3	18.0
	187	3.0	5.2	6.9	10.9	21.0
Ethyl	240	2.5	4.4	5.8	9.2	17.9
	187	2.9	5.1	6.7	10.7	20.9
Dupont	240	2.3	4.2	5.6	9.0	17.7
	187	2.7	4.9	6.6	10.5	20.7
Petrosar	240	2.2	4.1	5.5	8.9	17.6
	187	2.6	4.8	6.4	10.4	20.6
Novacor	240	1.1	3.0	4.4	7.8	16.5
	187	1.3	3.5	5.1	9.1	19.3
C.I.L.	240	-	0.2	1.7	5.1	13.7
	187	-	0.3	1.9	5.9	16.1
Murphy Drain	240	-	-	-	2.6	11.2
	187	-	-	-	3.0	13.2

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TABLE IV - VALUES OF "TC", THE CRITICAL SPILL DURATION TIME, IN HOURS

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE Lambton Gen. Station	Head of Chenal Ecarte	Walpole Island	Wallaceburg
Esso Petroleum #3 Separator	240 187	0.58 0.66	0.83 0.95	0.91 1.04	0.83 0.95
Esso Petroleum Impounding Basin	240 187	0.49 0.54	0.77 0.87	0.84 0.96	0.77 0.87
Esso Petroleum #9 Separator	240 187	0.57 0.65	0.83 0.94	0.90 1.03	0.83 0.94
Esso Chemical #11/12 Separator	240 187	0.49 0.54	0.76 0.86	0.84 0.96	0.76 0.86
Cole Drain	240 187	0.48 0.53	0.76 0.86	0.84 0.95	0.76 0.86
Polysar - 54"	240 187	0.57 0.64	0.83 0.94	0.90 1.03	0.83 0.94
Polysar - Stereo	240 187	0.56 0.63	0.83 0.94	0.90 1.03	0.83 0.94
Polysar - 66"	240 187	0.56 0.63	0.82 0.93	0.90 1.03	0.82 0.93
Polysar - 72"	240 187	0.56 0.63	0.82 0.93	0.90 1.03	0.82 0.93
Dow - 1st Street	240 187	0.56 0.63	0.82 0.93	0.90 1.03	0.82 0.93
Dow - 2nd Street	240 187	0.53 0.59	0.80 0.90	0.87 1.00	0.80 0.90
Dow - 3rd Street	240 187	0.55 0.62	0.82 0.93	0.89 1.02	0.82 0.93
Dow - 4th Street	240 187	0.55 0.62	0.81 0.92	0.89 1.02	0.81 0.92
Sun Oil - final	240 187	0.53 0.60	0.80 0.91	0.88 1.01	0.80 0.91
Talford Creek	240 187	0.47 0.53	0.76 0.87	0.85 0.97	0.76 0.87
Ethyl	240 187	0.42 0.48	0.73 0.84	0.82 0.94	0.73 0.84
Dupont	240 187	0.44 0.50	0.74 0.85	0.83 0.95	0.74 0.85
Petrosar	240 187	0.41 0.46	0.72 0.83	0.81 0.93	0.72 0.83
Novacor	240 187	0.37 0.42	0.70 0.80	0.79 0.91	0.70 0.80
C.I.L.	240 187	- -	0.74 0.90	0.81 0.98	0.74 0.90
Murphy Drain	240 187	- -	0.35 0.45	0.48 0.59	0.35 0.45

TABLE IV - VALUES OF "TC", THE CRITICAL SPILL DURATION TIME, IN HOURS
Cont'd

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE Stag Island	TO INTAKE Fawn Island
Esso Petroleum #3 Separator	240 187	0.41 0.45	0.76 0.84
Esso Petroleum Impounding Basin	240 187	0.28 0.32	0.68 0.75
Esso Petroleum #9 Separator	240 187	0.39 0.43	0.75 0.83
Esso Chemical #11/12 Separator	240 187	0.27 0.31	0.68 0.75
Cole Drain	240 187	0.26 0.31	0.68 0.74
Polysar - 54"	240 187	0.38 0.42	0.75 0.82
Polysar - Stereo	240 187	0.38 0.41	0.74 0.81
Polysar - 66"	240 187	0.37 0.41	0.74 0.81
Polysar - 72"	240 187	0.37 0.40	0.74 0.81
Dow - 1st Street	240 187	0.37 0.40	0.74 0.81
Dow - 2nd Street	240 187	0.32 0.35	0.71 0.77
Dow - 3rd Street	240 187	0.36 0.39	0.73 0.80
Dow - 4th Street	240 187	0.35 0.38	0.73 0.80
Sun Oil - final	240 187	0.34 0.35	0.73 0.79
Talford Creek	240 187	0.22 0.20	0.68 0.73
Ethyl	240 187	0.18 0.14	0.66 0.70
Dupont	240 187	0.15 0.14	0.66 0.72
Petrosar	240 187	0.09 0.09	0.64 0.69
Novacar	240 187	- -	0.61 0.66
C.I.L.	240 187	- -	0.60 0.66

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TABLE IV - VALUES OF "TC", THE CRITICAL SPILL DURATION TIME, IN HOURS
(cont'd) (For Michigan Intakes)

FROM OUTFALL	Total River Discharge CFS / 1000	TO St. Clair	East China Township	Marine City	INTAKE Algonac	Old Club
Esso Petroleum #3 Separator	240	4.5	5.5	6.0	7.0	10.0
	187	5.5	6.7	7.3	8.7	11.7
Esso Petroleum Impounding Basin	240	4.4	5.4	5.9	7.0	10.0
	187	5.4	6.6	7.2	8.6	11.6
Esso Petroleum #9 Separator	240	4.3	5.3	5.8	6.9	9.9
	187	5.3	6.5	7.2	8.6	11.5
Esso Chemical #11/12 Separator	240	4.3	5.3	5.8	6.9	9.9
	187	5.3	6.5	7.2	8.6	11.5
Cole Drain	240	4.3	5.3	5.8	6.9	9.9
	187	5.2	6.5	7.1	8.5	11.5
Polysar - 54"	240	4.2	5.3	5.8	6.9	9.9
	187	5.2	6.5	7.1	8.5	11.4
Polysar - Stereo	240	4.2	5.2	5.7	6.8	9.8
	187	5.2	6.4	7.1	8.4	11.4
Polysar - 66"	240	4.2	5.2	5.7	6.8	9.8
	187	5.1	6.4	7.0	8.4	11.4
Polysar - 72"	240	4.2	5.2	5.7	6.8	9.8
	187	5.1	6.4	7.0	8.4	11.4
Dow - 1st Street	240	4.2	5.2	5.7	6.8	9.8
	187	5.1	6.4	7.0	8.4	11.4
Dow - 2nd Street	240	4.1	5.2	5.7	6.8	9.8
	187	5.1	6.4	7.0	8.4	11.4
Dow - 3rd Street	240	4.1	5.1	5.7	6.8	9.7
	187	5.0	6.3	7.0	8.4	11.3
Dow - 4th Street	240	4.1	5.1	5.6	6.8	9.7
	187	5.0	6.3	6.9	8.3	11.3
Sun Oil - final	240	3.9	5.0	5.5	6.7	9.6
	187	4.8	6.1	6.8	8.2	11.2
Talford Creek	240	3.3	-	5.1	6.4	9.3
	187	4.1	-	6.3	7.8	10.8
Ethyl	240	3.2	-	5.1	6.3	9.2
	187	4.0	-	6.2	7.8	10.7
Dupont	240	-	-	5.0	6.2	9.2
	187	-	-	6.1	7.7	10.6
Petrosar	240	-	-	5.0	6.2	9.1
	187	-	-	6.1	7.7	10.6
Novacor	240	-	-	4.5	5.9	8.7
	187	-	-	5.5	7.2	10.1
C.I.L.	240	-	-	-	5.9	9.3
	187	-	-	-	7.1	11.1
Murphy Drain	240	-	-	-	-	7.9
	187	-	-	-	-	9.4

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TABLE V - VALUES OF "TAPD", THE TIME BETWEEN ARRIVAL AND PEAK, OR PEAK AND DEPARTURE, IN HOURS

FROM OUTFALL	Total River Discharge CFS/1000	TO Lambton Gen. Station	Head of Chenal Ecarte	INTAKE Walpole Island	Wallaceburg
Esso Petroleum #3 Separator	240 187	1.5 1.7	2.1 2.4	2.3 2.6	6.3 7.1
Esso Petroleum Impounding Basin	240 187	1.2 1.4	1.9 2.2	2.1 2.4	6.1 6.9
Esso Petroleum #9 Separator	240 187	1.4 1.6	2.1 2.4	2.3 2.6	6.3 7.1
Esso Chemical #11/12 Separator	240 187	1.2 1.4	1.9 2.2	2.1 2.4	6.1 6.9
Cole Drain	240 187	1.2 1.3	1.9 2.2	2.1 2.4	6.1 6.9
Polysar - 54"	240 187	1.4 1.6	2.1 2.4	2.3 2.6	6.3 7.1
Polysar - Stereo	240 187	1.4 1.6	2.1 2.4	2.3 2.6	6.3 7.1
Polysar - 66"	240 187	1.4 1.6	2.1 2.3	2.3 2.6	6.3 7.0
Polysar - 72"	240 187	1.4 1.6	2.1 2.3	2.3 2.6	6.3 7.0
Dow - 1st Street	240 187	1.4 1.6	2.1 2.3	2.3 2.6	6.3 7.0
Dow - 2nd Street	240 187	1.3 1.5	2.0 2.3	2.2 2.5	6.2 7.0
Dow - 3rd Street	240 187	1.4 1.6	2.1 2.3	2.2 2.6	6.3 7.0
Dow - 4th Street	240 187	1.4 1.6	2.0 2.3	2.2 2.6	6.2 7.0
Sun Oil - final	240 187	1.3 1.5	2.0 2.3	2.2 2.5	6.2 7.0
Talford Creek	240 187	1.2 1.3	1.9 2.2	2.1 2.4	6.1 6.9
Ethyl	240 187	1.1 1.2	1.8 2.1	2.1 2.4	6.0 6.8
Dupont	240 187	1.1 1.3	1.9 2.1	2.1 2.4	6.1 6.8
Petrosar	240 187	1.0 1.2	1.8 2.1	2.0 2.3	6.0 6.8
Novacor	240 187	0.9 1.1	1.8 2.0	2.0 2.3	6.0 6.7
C.I.L.	240 187	- -	1.9 2.3	2.0 2.5	6.1 7.0
Murphy Drain	240 187	- -	0.9 1.1	1.2 1.5	5.1 5.8

TABLE V - VALUES OF "TAPD", THE TIME BETWEEN ARRIVAL AND PEAK, OR PEAK AND DEPARTURE, IN HOURS

Cont'd

FROM OUTFALL	Total River Discharge CFS / 1000	TO INTAKE	
		Stag Island	Fawn Island
Esso Petroleum #3 Separator	240 187	1.0 1.1	1.9 2.1
Esso Petroleum Impounding Basin	240 187	0.7 0.8	1.7 1.9
Esso Petroleum #9 Separator	240 187	0.9 1.0	1.9 2.0
Esso Chemical #11/12 Separator	240 187	0.7 0.8	1.7 1.9
Cole Drain	240 187	0.7 0.8	1.7 1.9
Polysar - 54"	240 187	0.9 1.0	1.9 2.0
Polysar - Stereo	240 187	0.9 1.0	1.9 2.0
Polysar - 66"	240 187	0.9 1.0	1.9 2.0
Polysar - 72"	240 187	0.9 1.0	1.9 2.0
Dow - 1st Street	240 187	0.9 1.0	1.9 2.0
Dow - 2nd Street	240 187	0.8 0.9	1.8 1.9
Dow - 3rd Street	240 187	0.9 1.0	1.9 2.0
Dow - 4th Street	240 187	0.9 1.0	1.9 2.0
Sun Oil - final	240 187	0.9 0.9	1.8 2.0
Talford Creek	240 187	0.6 0.5	1.7 1.8
Ethyl	240 187	0.4 0.4	1.7 1.8
Dupont	240 187	0.4 0.3	1.7 1.8
Petrosar	240 187	0.2 0.2	1.6 1.8
Novacor	240 187	- -	1.5 1.7
C.I.L.	240 187	- -	1.5 1.7

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TABLE V (cont'd) - VALUES OF "TAPD", THE TIME BETWEEN ARRIVAL AND PEAK, OR PEAK AND DEPARTURE, IN HOURS (for Michigan Intakes)

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE: St. Clair	East China Township	Marine City	Algonac	Old Club
Esso Petroleum #3 Separator	240	5.1	6.2	6.7	7.9	11.3
	187	6.3	7.6	8.3	9.8	13.2
Esso Petroleum Impounding Basin	240	5.0	6.1	6.6	7.9	11.2
	187	6.1	7.5	8.2	9.7	13.1
Esso Petroleum #9 Separator	240	4.9	6.0	6.6	7.8	11.2
	187	6.0	7.4	8.1	9.6	13.0
Esso Chemical #11/12 Separator	240	4.9	6.0	6.6	7.8	11.2
	187	6.0	7.4	8.1	9.6	13.0
Cole Drain	240	4.8	5.9	6.5	7.8	11.1
	187	5.9	7.3	8.0	9.6	12.9
Polysar - 54"	240	4.8	5.9	6.5	7.8	11.1
	187	5.9	7.3	8.0	9.5	12.9
Polysar - Stereo	240	4.8	5.9	6.5	7.7	11.1
	187	5.8	7.3	8.0	9.5	12.9
Polysar - 66"	240	4.7	5.9	6.5	7.7	11.1
	187	5.8	7.2	7.9	9.5	12.9
Polysar - 72"	240	4.7	5.9	6.5	7.7	11.1
	187	5.8	7.2	7.9	9.5	12.9
Dow - 1st Street	240	4.7	5.9	6.5	7.7	11.1
	187	5.8	7.2	7.9	9.5	12.9
Dow - 2nd Street	240	4.7	5.8	6.4	7.7	11.0
	187	5.7	7.2	7.9	9.4	12.8
Dow - 3rd Street	240	4.6	5.8	6.4	7.7	11.0
	187	5.7	7.1	7.9	9.4	12.8
Dow - 4th Street	240	4.6	5.8	6.3	7.6	10.9
	187	5.6	7.1	7.8	9.4	12.8
Sun Oil - final	240	4.4	5.6	6.2	7.5	10.8
	187	5.4	6.9	7.7	9.3	12.6
Talford Creek	240	3.7	-	5.8	7.2	10.5
	187	4.6	-	7.1	8.8	12.1
Ethyl	240	3.6	-	5.7	7.1	10.4
	187	4.5	-	7.0	8.8	12.1
Dupont	240	-	-	5.6	7.0	10.3
	187	-	-	6.9	8.7	12.0
Petrosar	240	-	-	5.6	7.0	10.3
	187	-	-	6.9	8.7	12.0
Novacor	240	-	-	5.1	6.6	9.8
	187	-	-	6.2	8.1	11.4
C.I.L.	240	-	-	-	6.6	10.5
	187	-	-	-	8.0	12.6
Murphy Drain	240	-	-	-	-	8.9
	187	-	-	-	-	10.6

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TABLE VI - SELECTION OF THE GENERAL DECAY FACTOR FOR SOME CONTAMINANTS

CONTAMINANT NAME	GENERAL DECAY FACTOR
Ammonia	DF3
Benzene	DF3
Benzo (a) pyrene	DF8
Benzo (b) thiophene	DF5
Carbon Tetrachloride	DF3
Chlorine	DF9
Chloroethane	DF3
Chloroform	DF3
1,2-dichloroethane	DF3
Dichloromethane	DF3
Dichloropropane	DF3
Mirex	DF3
Naphthalene	DF7
p-Cresol	DF6
Phenol	DF4
Toluene	DF3
1,2-transdichloroethane	DF3
(conservative, no decay	DF1)

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TABLE VII - VALUES OF "NUMDF", THE NUMERICAL VALUE OF THE GENERAL DECAY FACTORS FOR DIFFERENT VALUES OF "TT", THE MEAN TRAVEL TIME

FOR A VALUE OF MEAN TRAVEL TIME (TT) IN HRS, OF:	FOR GENERAL DECAY FACTOR OF:								
	DF1	DF2	DF3	DF4	DF5	DF6	DF7	DF8	DF9
1 to 1.9	1.000	.996	.993	.986	.972	.944	.891	.794	.631
2 to 2.9	"	.993	.986	.972	.944	.891	.794	.631	.398
3 to 3.9	"	.989	.979	.958	.917	.841	.708	.501	.251
4 to 4.9	"	.986	.972	.944	.891	.794	.631	.398	.158
5 to 5.9	"	.982	.965	.931	.866	.750	.562	.316	.100
6 to 6.9	"	.979	.956	.917	.841	.708	.501	.251	.063
7 to 7.9	"	.975	.951	.904	.817	.668	.446	.199	.040
8 to 8.9	"	.972	.944	.891	.794	.631	.398	.158	.025
9 to 9.9	"	.968	.937	.878	.772	.595	.355	.126	.016
10 to 10.9	"	.965	.931	.866	.750	.562	.316	.100	.010
11 to 11.9	"	.961	.924	.854	.728	.531	.282	.079	.0063
12 to 12.9	"	.958	.917	.841	.708	.501	.251	.063	.0040
13 to 13.9	"	.954	.911	.829	.688	.473	.224	.050	.0025
14 to 14.9	"	.951	.904	.817	.668	.446	.199	.040	.0016
15 to 15.9	"	.947	.898	.806	.649	.421	.178	.032	.0010
16 to 16.9	"	.944	.891	.794	.631	.398	.158	.025	.00063
17 to 17.9	"	.941	.885	.783	.613	.376	.141	.020	.00040
18 to 18.9	"	.937	.878	.772	.595	.355	.126	.016	.00025
19 to 19.9	"	.934	.872	.761	.579	.335	.112	.013	.00016
20 to 20.9	"	.931	.866	.750	.562	.316	.100	.010	.00010
21 to 21.9	"	.927	.860	.739	.546	.298	.089	.0079	.000063
22 to 22.9	"	.924	.854	.728	.531	.282	.079	.0063	.000040
23 to 23.9	"	.921	.847	.718	.516	.266	.071	.0050	.000025

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TABLE VIII - (USE THIS TABLE WHEN T<TC)
VALUES OF "PC", THE NO-DECAY PEAK CONCENTRATION IN ug/L, FOR A LOAD OF 1. KG

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE Lambton Gen. Station	Head of Chenal Ecarte	Walpole Island	Wallaceburg
Esso Petroleum #3 Separator	240 187	0.374 0.435	0.190 0.219	0.170 0.197	0.190 0.219
Esso Petroleum Impounding Basin	240 187	0.344 0.402	0.185 0.214	0.167 0.192	0.185 0.214
Esso Petroleum #9 Separator	240 187	0.395 0.460	0.195 0.225	0.174 0.201	0.195 0.225
Esso Chemical #11/12 Separator	240 187	0.351 0.413	0.186 0.217	0.168 0.195	0.186 0.217
Cole Drain	240 187	0.349 0.410	0.186 0.217	0.168 0.195	0.186 0.217
Polysar - 54"	240 187	0.409 0.476	0.198 0.229	0.177 0.204	0.198 0.229
Polysar - Stereo	240 187	0.413 0.481	0.199 0.230	0.178 0.205	0.199 0.230
Polysar - 66"	240 187	0.415 0.483	0.200 0.231	0.178 0.205	0.200 0.231
Polysar - 72"	240 187	0.416 0.485	0.200 0.231	0.179 0.206	0.200 0.231
Dow - 1st Street	240 187	0.418 0.487	0.200 0.231	0.179 0.206	0.200 0.231
Dow - 2nd Street	240 187	0.403 0.470	0.197 0.228	0.178 0.204	0.197 0.228
Dow - 3rd Street	240 187	0.431 0.502	0.203 0.235	0.182 0.209	0.203 0.235
Dow - 4th Street	240 187	0.437 0.509	0.205 0.237	0.182 0.210	0.205 0.237
Sun Oil - final	240 187	0.462 0.539	0.210 0.243	0.187 0.215	0.210 0.243
Talford Creek	240 187	0.590 0.688	0.232 0.268	0.205 0.236	0.232 0.268
Ethyl	240 187	0.561 0.655	0.230 0.265	0.202 0.233	0.230 0.265
Dupont	240 187	0.634 0.740	0.240 0.277	0.210 0.242	0.240 0.277
Petrosar	240 187	0.606 0.698	0.236 0.272	0.207 0.238	0.236 0.272
Novacor	240 187	0.711 0.801	0.253 0.292	0.221 0.254	0.253 0.292
C.I.L.	240 187	- -	0.624 0.666	0.496 0.534	0.624 0.666
Murphy Drain	240 187	- -	1.780 1.820	1.070 1.120	1.780 1.820

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TABLE VIII - (USE THIS TABLE WHEN T<TC) VALUES OF "PC", THE NO-DECAY PEAK CONCENTRATION IN ug/L, FOR A LOAD OF 1. Kg

(Cont'd)

FROM OUTFALL	Total River Discharge CFS / 1000	TO INTAKE	
		Stag Island (@ Intake)	Fawn Island (@ Intake)
Esso Petroleum #3 Separator	240 187	.162 .175	.151 .182
Esso Petroleum Impounding Basin	240 187	.132 .133	.149 .178
Esso Petroleum #9 Separator	240 187	.155 .164	.155 .190
Esso Chemical #11/12 Separator	240 187	.129 .132	.153 .181
Cole Drain	240 187	.140 .147	.152 .183
Polysar - 54"	240 187	.152 .156	.158 .195
Polysar - Stereo	240 187	.149 .152	.159 .196
Polysar - 66"	240 187	.148 .147	.159 .197
Polysar - 72"	240 187	.148 .147	.160 .197
Dow - 1st Street	240 187	.148 .147	.160 .197
Dow - 2nd Street	240 187	.131 .118	.159 .194
Dow - 3rd Street	240 187	.138 .136	.162 .200
Dow - 4th Street	240 187	.137 .126	.163 .201
Sun Oil - final	240 187	.107 .099	.168 .208
Talford Creek	240 187	0 0	.190 .236
Ethyl	240 187	0 0	.190 .237
Dupont	240 187	0 0	.197 .240
Petrosar	240 187	0 0	.197 .240
Novacor	240 187	- -	.222 .272
C.I.L.	240 187	- -	.903 1.140

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TABLE VIII - (USE THIS TABLE WHEN T<TC) VALUES OR "PC", THE NO-DECAY PEAK
(cont'd) CONCENTRATION IN ug/L, FOR A LOAD OF 1 Kg (For Michigan Intakes)

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE St. Clair	East China Township	Marine City	Algonac	Old Club
Esso Petroleum #3 Separator	240	.00153	.00054	.00091	.00171	.00636
	187	.00121	.00037	.00067	.00142	.00656
Esso Petroleum Impounding Basin	240	.00142	.00050	.00085	.00167	.00638
	187	.00111	.00034	.00063	.00138	.00661
Esso Petroleum #9 Separator	240	.00132	.00047	.00082	.00163	.00641
	187	.00104	.00031	.00060	.00135	.00661
Esso Chemical #11/12 Separator	240	.00130	.00046	.00081	.00162	.00642
	187	.00102	.00030	.00059	.00134	.00661
Cole Drain	240	.00122	.00042	.00078	.00159	.00644
	187	.00092	.00028	.00056	.00133	.00664
Polysar - 54"	240	.00118	.00042	.00078	.00157	.00644
	187	.00091	.00028	.00057	.00130	.00664
Polysar - Stereo	240	.00116	.00040	.00076	.00157	.00647
	187	.00088	.00026	.00055	.00128	.00664
Polysar - 66"	240	.00114	.00040	.00075	.00157	.00648
	187	.00086	.00026	.00054	.00128	.00664
Polysar - 72"	240	.00114	.00040	.00075	.00157	.00648
	187	.00086	.00026	.00054	.00128	.00664
Dow - 1st Street	240	.00112	.00040	.00075	.00155	.00649
	187	.00084	.00026	.00054	.00127	.00664
Dow - 2nd Street	240	.00106	.00038	.00072	.00155	.00649
	187	.00079	.00024	.00052	.00126	.00668
Dow - 3rd Street	240	.00101	.00036	.00071	.00153	.00649
	187	.00075	.00023	.00050	.00124	.00668
Dow - 4th Street	240	.00099	.00034	.00068	.00151	.00649
	187	.00072	.00022	.00048	.00122	.00668
Sun Oil - final	240	.00079	.00029	.00061	.00144	.00654
	187	.00056	.00018	.00042	.00116	.00671
Talford Creek	240	.00027	0	.00039	.00121	.00665
	187	.00016	0	.00025	.00095	.00678
Ethyl	240	.00023	0	.00036	.00119	.00670
	187	.00013	0	.00023	.00092	.00679
Dupont	240	0	0	.00032	.00116	.00670
	187	0	0	.00020	.00089	.00679
Petrosar	240	0	0	.00031	.00112	.00670
	187	0	0	.00020	.00087	.00679
Novacor	240	0	0	.00015	.00087	.00683
	187	0	0	.00008	.00064	.00684
C.I.L.	240	-	0	0	.00010	.00550
	187	-	0	0	.00007	.00549
Murphy Drain	240	-	-	-	0	.00478
	187	-	-	-	0	.00464

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TABLE IX - (USE THIS TABLE WHEN T>TC)
VALUES OF "EC", THE NO-DECAY PEAK EQUILIBRIUM
CONCENTRATION, IN ug/L, FOR A LOADING RATE OF 1 Kg/s

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE			
		Lambton Gen. Station	Head of Chenal Ecarte	Walpole Island	Wallaceburg
Esso Petroleum #3 Separator	240 187	784. 1,040.	569. 751.	558. 736.	569. 751.
Esso Petroleum Impounding Basin	240 187	606. 786.	509. 668.	506. 665.	509. 668.
Esso Petroleum #9 Separator	240 187	811. 1,070	579. 764.	568. 749.	579. 764.
Esso Chemical #11/12 Separator	240 187	626. 802.	516. 675.	509. 671.	516. 675.
Cole Drain	240 187	601. 782.	510. 669.	507. 667.	510. 669.
Polysar - 54"	240 187	828. 1,090.	585. 772.	573. 757.	585. 772.
Polysar - Stereo	240 187	833. 1,100.	587. 775.	575. 759.	587. 775.
Polysar - 66"	240 187	835. 1,100.	588. 776.	576. 760.	588. 776.
Polysar - 72"	240 187	836. 1,100.	588. 776.	576. 761.	588. 776.
Dow - 1st Street	240 187	839. 1,110.	589. 777.	577. 762.	589. 777.
Dow - 2nd Street	240 187	770. 1,020.	568. 749.	556. 734.	568. 749.
Dow - 3rd Street	240 187	853. 1,130.	594. 783.	582. 768.	594. 783.
Dow - 4th Street	240 187	860. 1,130.	597. 787.	584. 771.	597. 787.
Sun Oil - final	240 187	892. 1,170.	606. 799.	593. 783.	606. 799.
Talford Creek	240 187	1,006. 1,320.	639. 842.	625. 823.	639. 842.
Ethyl	240 187	864. 1,140.	608. 801.	596. 786.	608. 801.
Dupont	240 187	1,015. 1,330.	643. 847.	628. 827.	643. 847.
Petrosar	240 187	894. 1,170.	617. 811.	606. 797.	617. 811.
Novacar	240 187	942 1,220	641 844	631 832	641 844
C.I.L.	240 187	- -	1,670. 2,150.	1,450. 1,880.	1,670. 2,150.
Murphy Drain	240 187	- -	2,250. 2,970.	1,830. 2,400.	2,250. 2,970.

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TABLE IX - (Cont'd) (USE THIS TABLE WHEN T>TC)
VALUES OF "EC", THE NO-DECAY PEAK EQUILIBRIUM CONCENTRATION, in ug/L, FOR A LOADING RATE OF 1 Kg/s

FROM OUTFALL	Total River Discharge CFS/1000	TO INTAKE	
		Stag Island (@ Intake)	Fawn Island (@ Intake)
Esso Petroleum #3 Separator	240 187	236. 284.	413. 552.
Esso Petroleum Impounding Basin	240 187	135. 153.	368. 485.
Esso Petroleum #9 Separator	240 187	218. 251.	420. 563.
Esso Chemical #11/12 Separator	240 187	127. 148.	373. 490.
Cole Drain	240 187	133. 161.	370. 491.
Polysar - 54"	240 187	211. 231.	425. 572.
Polysar - Stereo	240 187	203. 222.	427. 574.
Polysar - 66"	240 187	201. 215.	427. 575.
Polysar - 72"	240 187	201. 215.	428. 575.
Dow - 1st Street	240 187	199. 212.	428. 573.
Dow - 2nd Street	240 187	151. 147.	407. 539
Dow - 3rd Street	240 187	178. 188.	430. 578.
Dow - 4th Street	240 187	175. 171.	433. 582.
Sun Oil - final	240 187	130. 124.	440. 592.
Talford Creek	240 187	0. 0.	466. 622.
Ethyl	240 187	0. 0.	449. 594.
Dupont	240 187	0. 0.	468. 618.
Petrosar	240 187	0. 0.	450. 597.
Novacor	240 187	- -	491. 650.
C.I.L.	240 187	- -	1,950. 2,710.

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TABLE IX - (USE THIS TABLE WHEN T>TC)
(cont'd) VALUES OF "EC". THE NO-DECAY PEAK EQUILIBRIUM CONCENTRATION, IN ug/L, FOR A LOADING RATE OF 1 Kg/S (For Michigan Intakes)

FROM OUTFALL	Total River Discharge CFS / 1000	TO INTAKE				
		St. Clair	East China Township	Marine City	Algonac	Old Club
Esso Petroleum #3 Separator	240 187	24.8 24.1	10.7 9.0	19.5 17.6	43.4 44.3	230. 275.
Esso Petroleum Impounding Basin	240 187	22.5 21.7	9.7 8.1	18.1 16.4	41.9 42.7	229. 275.
Esso Petroleum #9 Separator	240 187	20.7 19.9	8.9 7.4	17.1 15.4	40.7 41.4	229. 274.
Esso Chemical #11/12 Separator	240 187	20.3 19.5	8.7 7.2	16.9 15.2	40.4 41.1	229. 274.
Cole Drain	240 187	18.7 17.4	8.0 6.5	16.2 14.4	39.5 40.4	229. 274.
Polysar - 54"	240 187	17.9 17.1	8.0 6.4	16.1 14.4	38.7 39.6	228. 273.
Polysar - Stereo	240 187	17.6 16.3	7.6 6.1	15.8 14.1	38.8 38.8	228. 272.
Polysar - 66"	240 187	17.2 15.9	7.5 6.1	15.5 13.7	38.6 38.8	228. 272.
Polysar - 72"	240 187	17.2 15.9	7.4 5.9	15.4 13.7	38.6 38.8	228. 272.
Dow - 1st Street	240 187	16.9 15.6	7.4 5.9	15.4 13.7	38.1 38.6	228. 272.
Dow - 2nd Street	240 187	15.8 14.5	7.0 5.6	14.7 13.1	37.9 37.8	227. 272.
Dow - 3rd Street	240 187	14.8 13.5	6.6 5.3	14.4 12.4	37.3 37.1	227. 272.
Dow - 4th Street	240 187	14.5 12.9	6.3 4.9	13.7 12.0	36.8 36.6	227. 271.
Sun Oil - final	240 187	11.0 9.6	5.1 3.9	12.1 10.3	34.6 34.3	226. 270.
Talford Creek	240 187	3.2 2.4	0 0	7.2 5.8	27.7 26.9	222. 263.
Ethyl	240 187	2.6 1.8	0 0	6.6 5.3	27.0 25.7	222. 262.
Dupont	240 187	0 0	0 0	5.8 4.4	26.0 24.7	220. 261.
Petrosar	240 187	0 0	0 0	5.5 4.3	25.1 24.0	220. 259.
Novacor	240 187	0 0	0 0	2.2 1.5	18.2 16.5	214. 250.
C.I.L.	240 187	- -	0 0	0 0	2.2 1.8	150. 181.
Murphy Drain	240 187	- -	- -	- -	0 0	110. 129.

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APPENDIX II:

FIGURES FOR THE

ST. CLAIR RIVER SPILL MANUAL

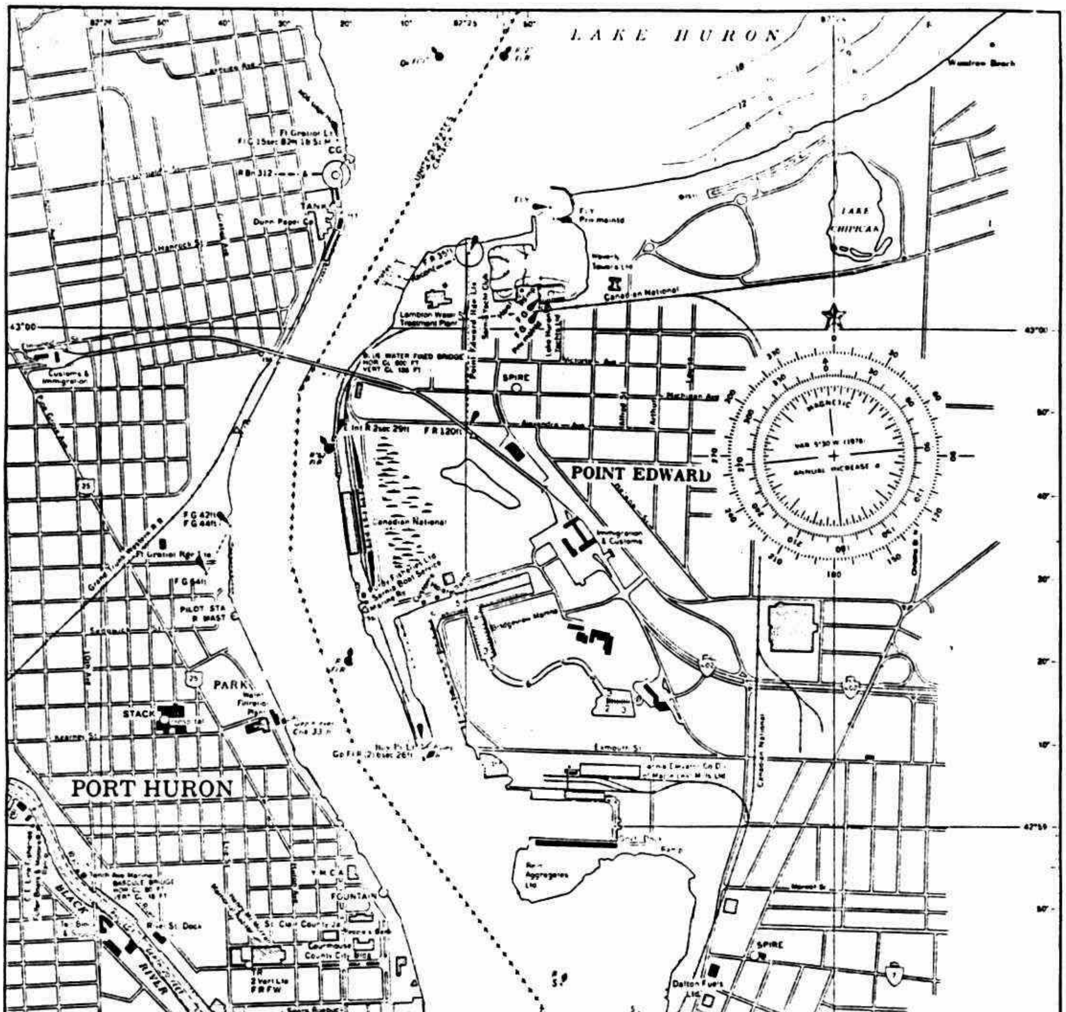

Figure 1: Locations of Outfalls 1 and 2.

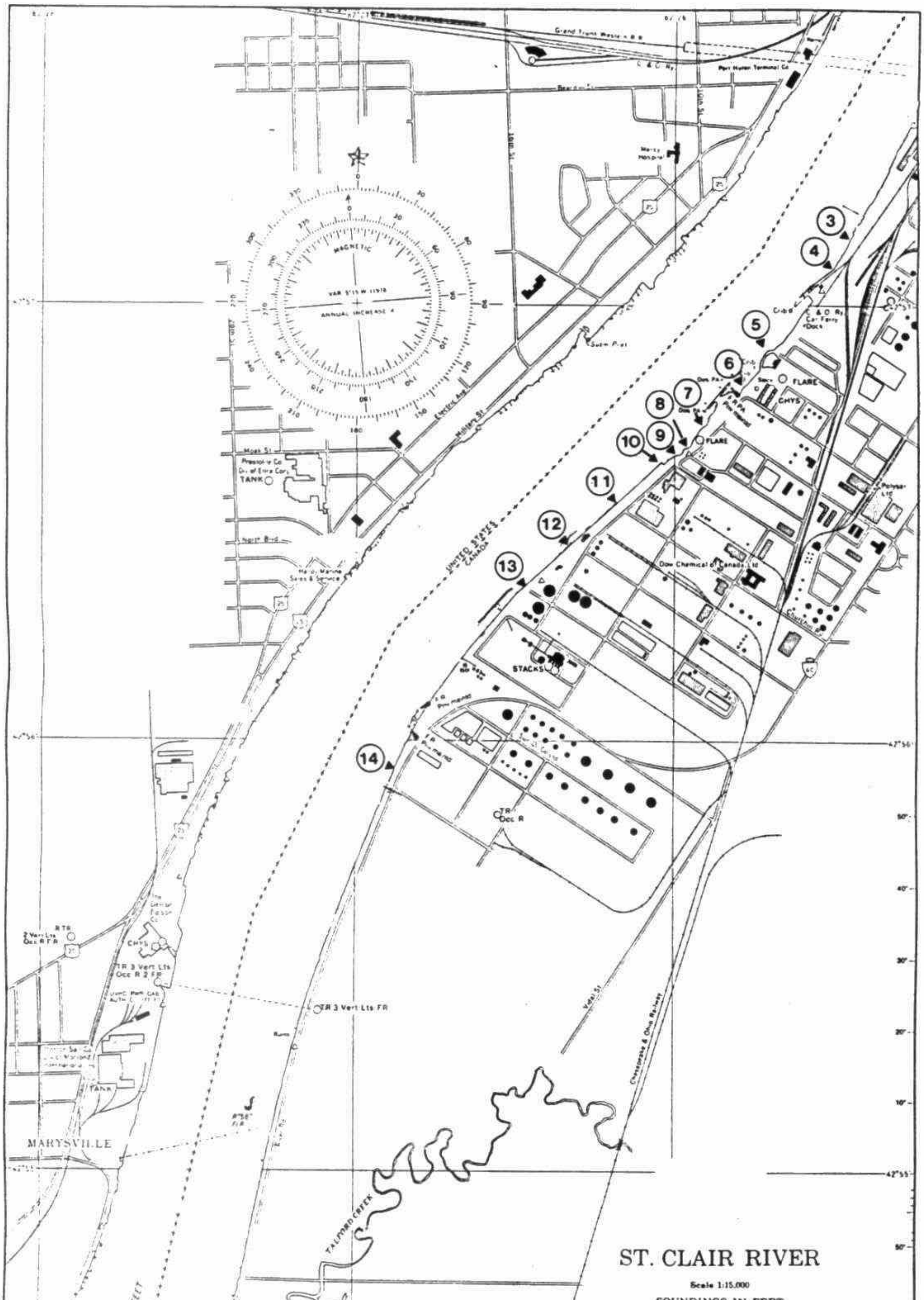

Figure 2: Locations of Outfalls 3 to 14.

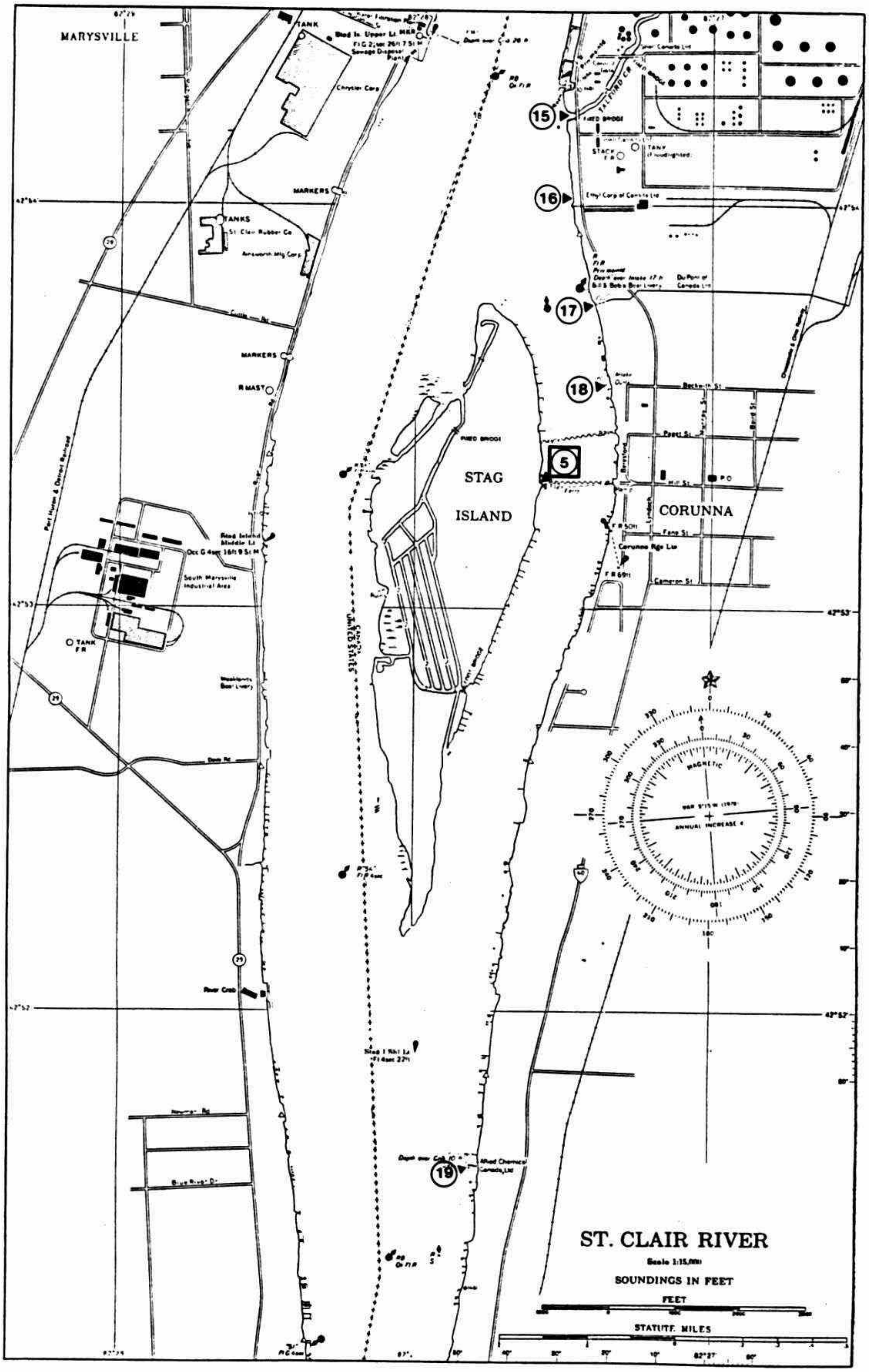

Figure 3: Locations of Outfalls 15 to 19, and Intake 5.

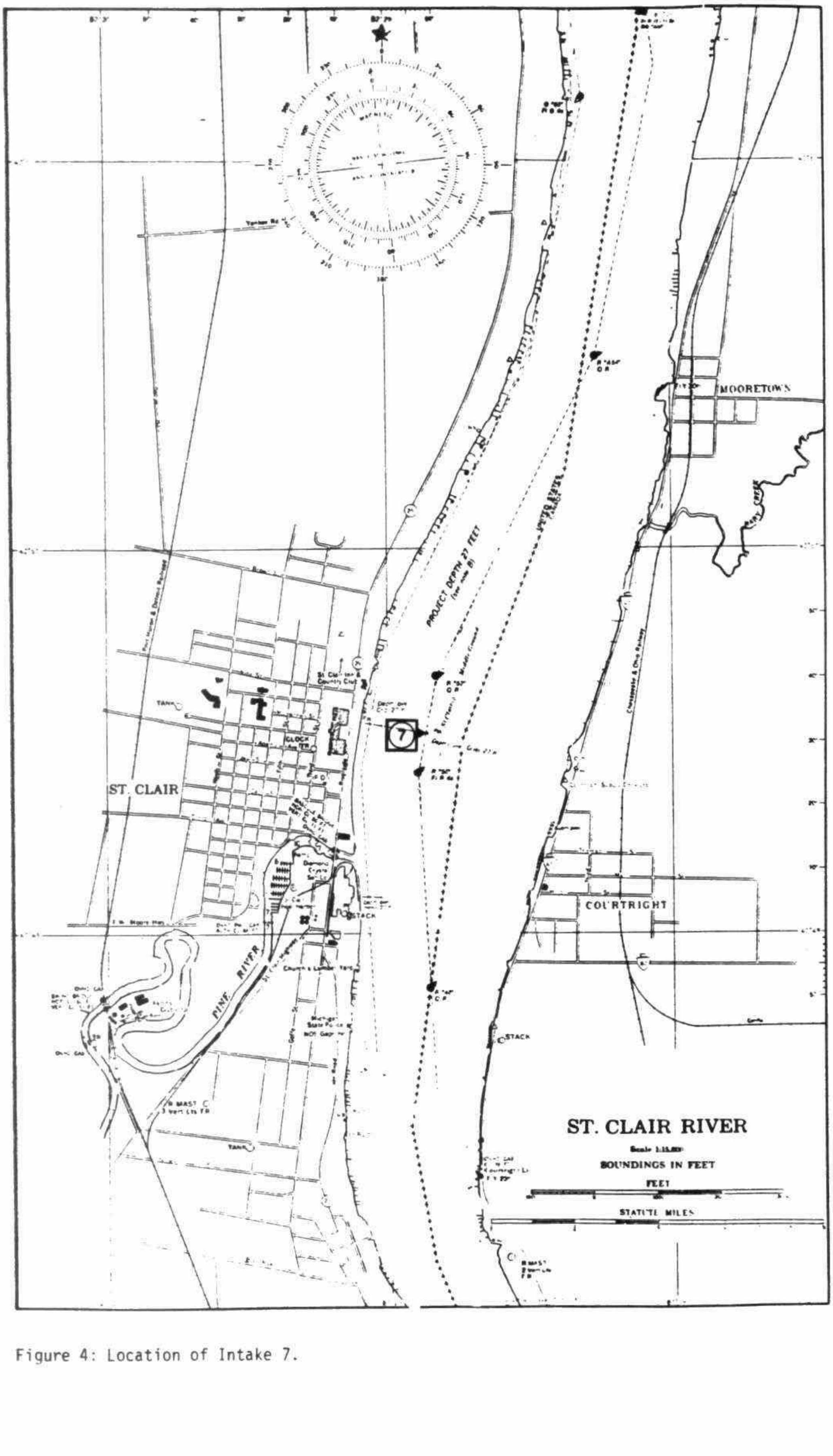

Figure 4: Location of Intake 7.

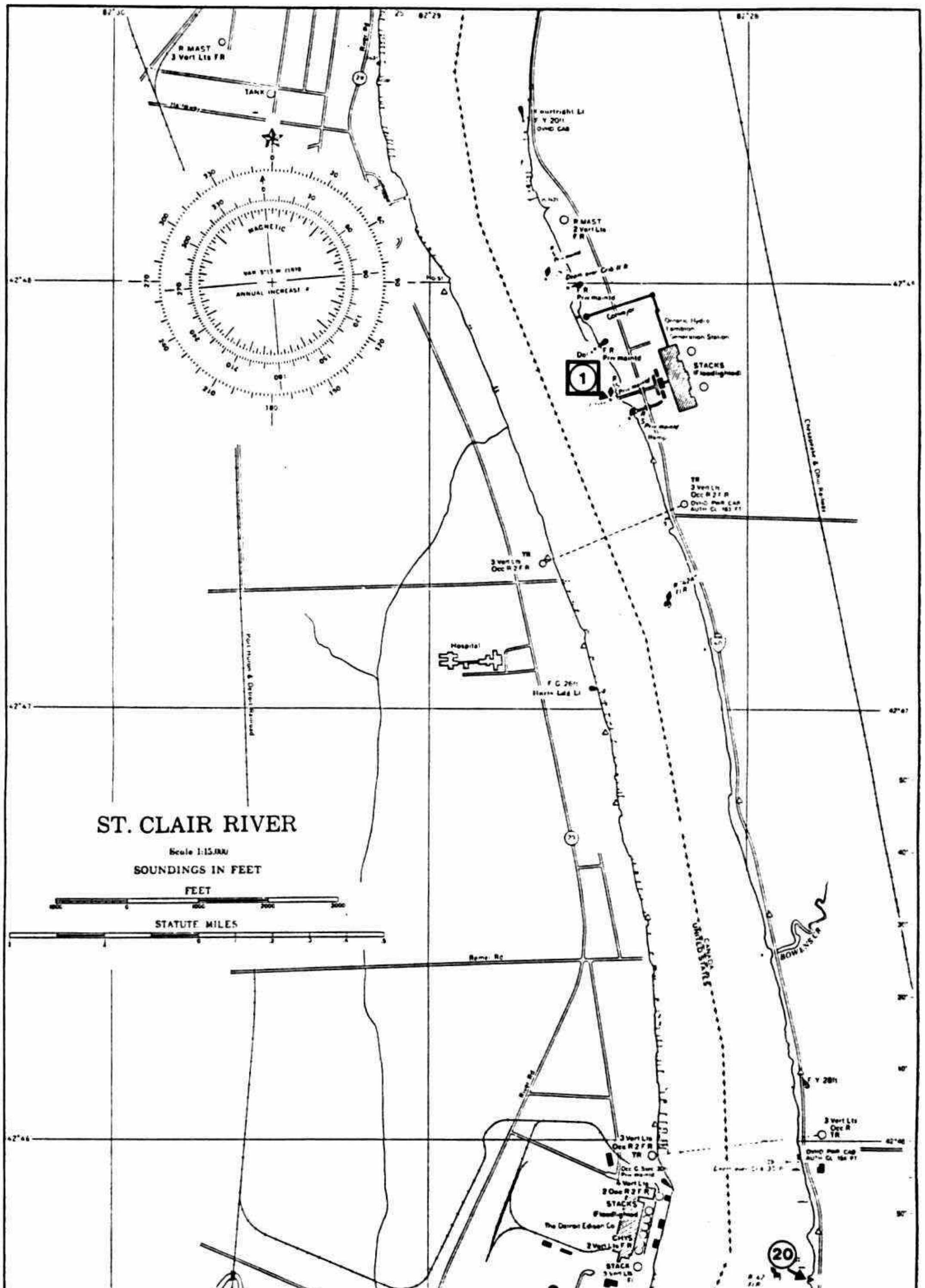

Figure 5: Locations of Outfall 20 and
Intake 1.

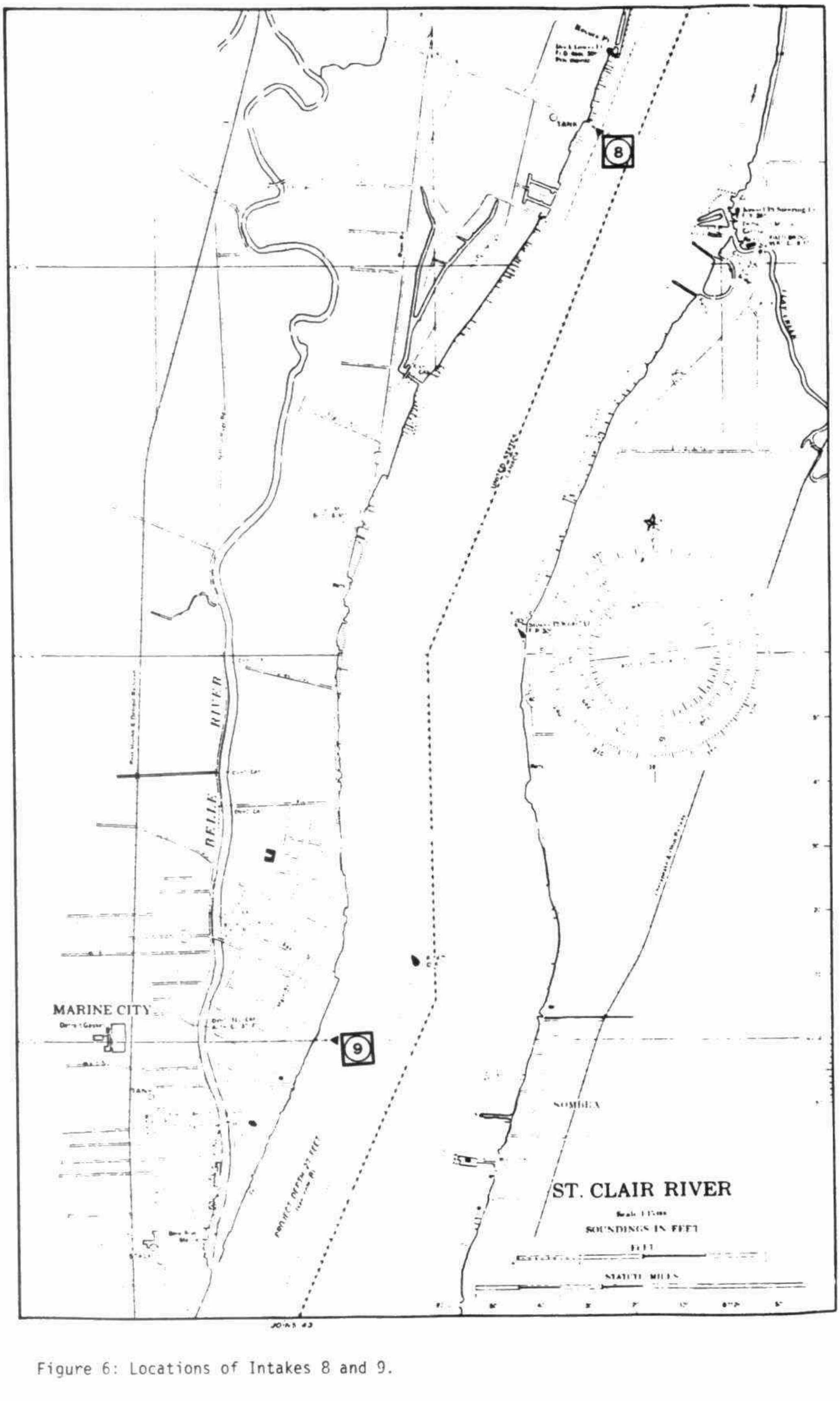

Figure 6: Locations of Intakes 8 and 9.

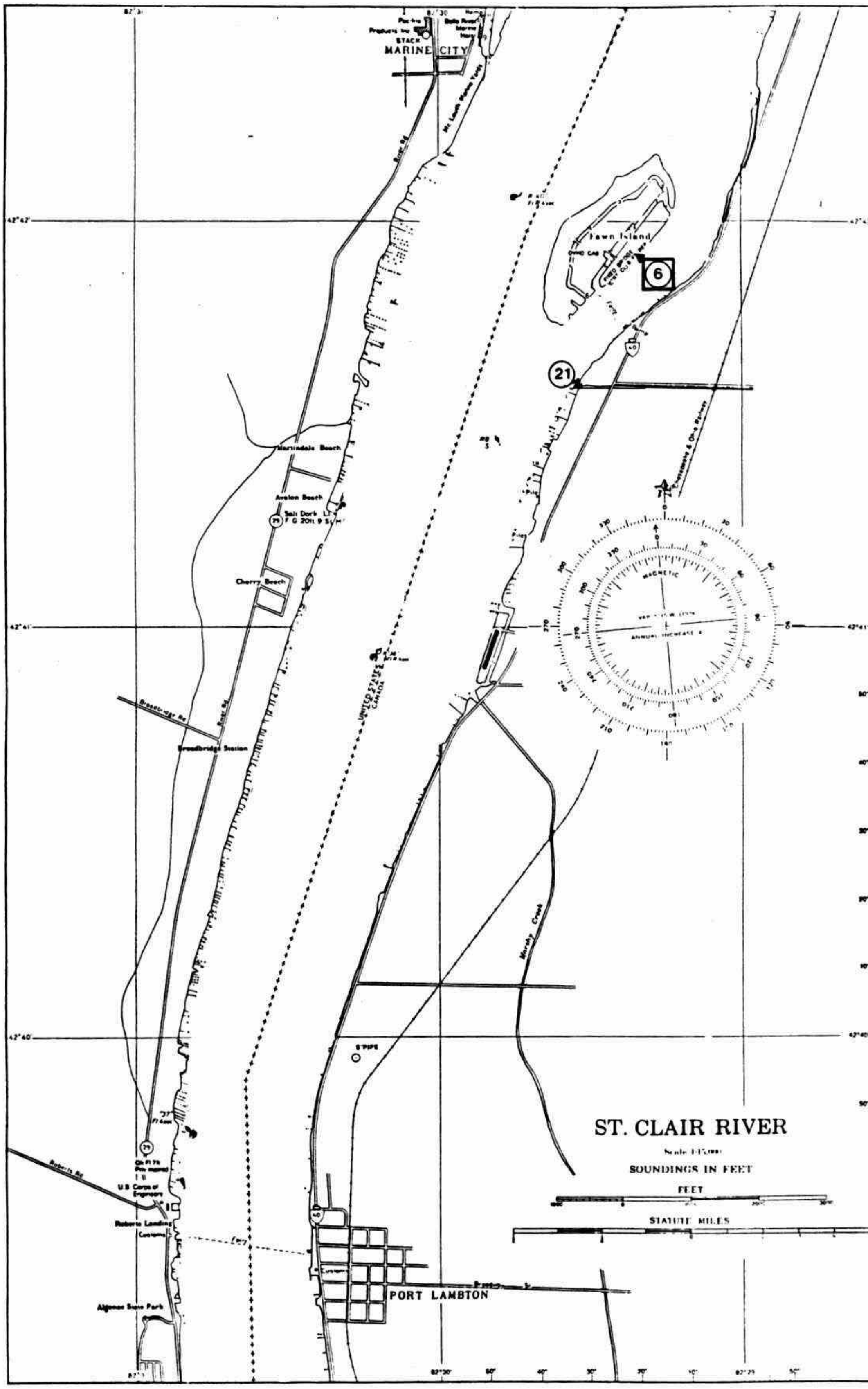

Figure 7: Location of Outfall 21 and Intake 6.

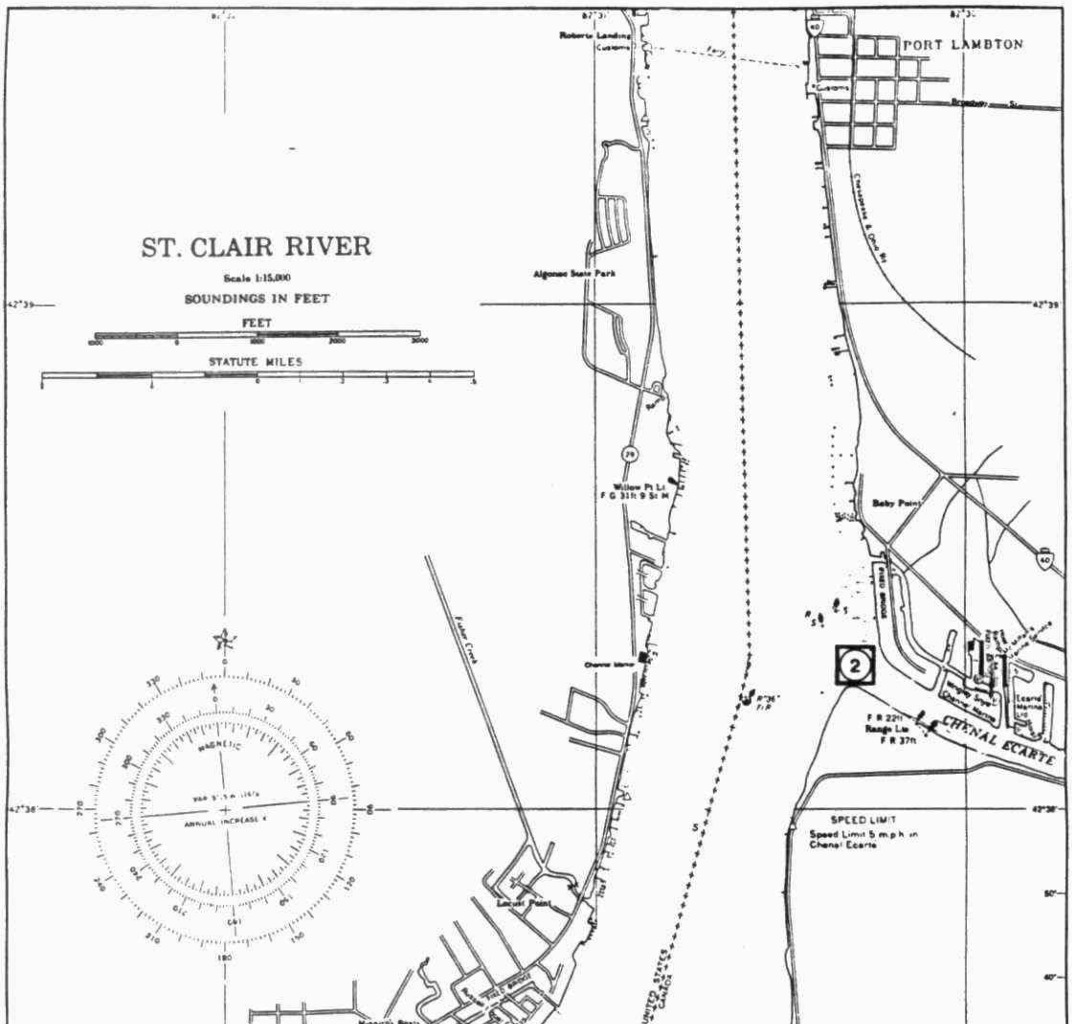

Fig. 8: Location of Intakes 2 and 3.

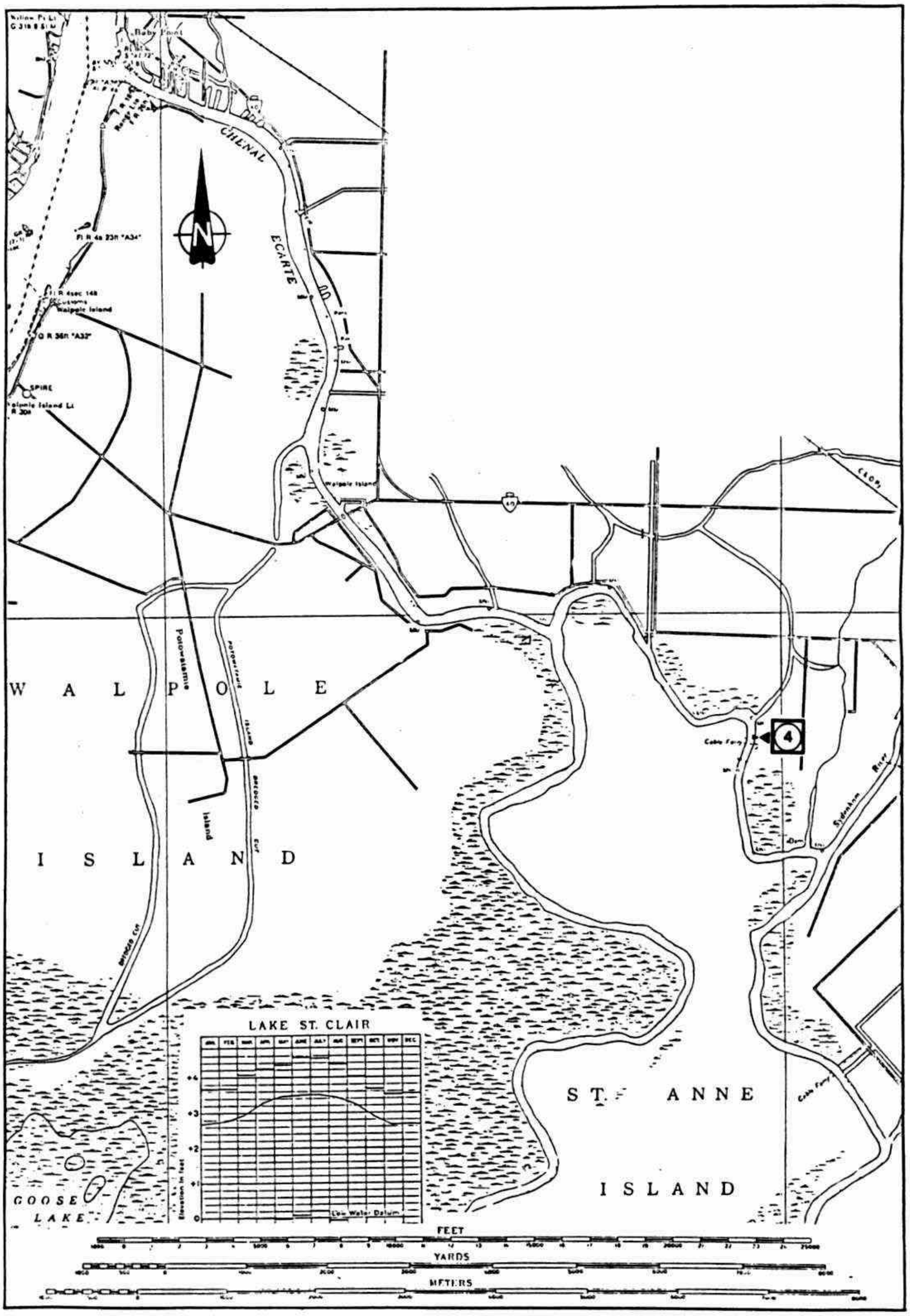

Fig. 9: Location of Intake 4.

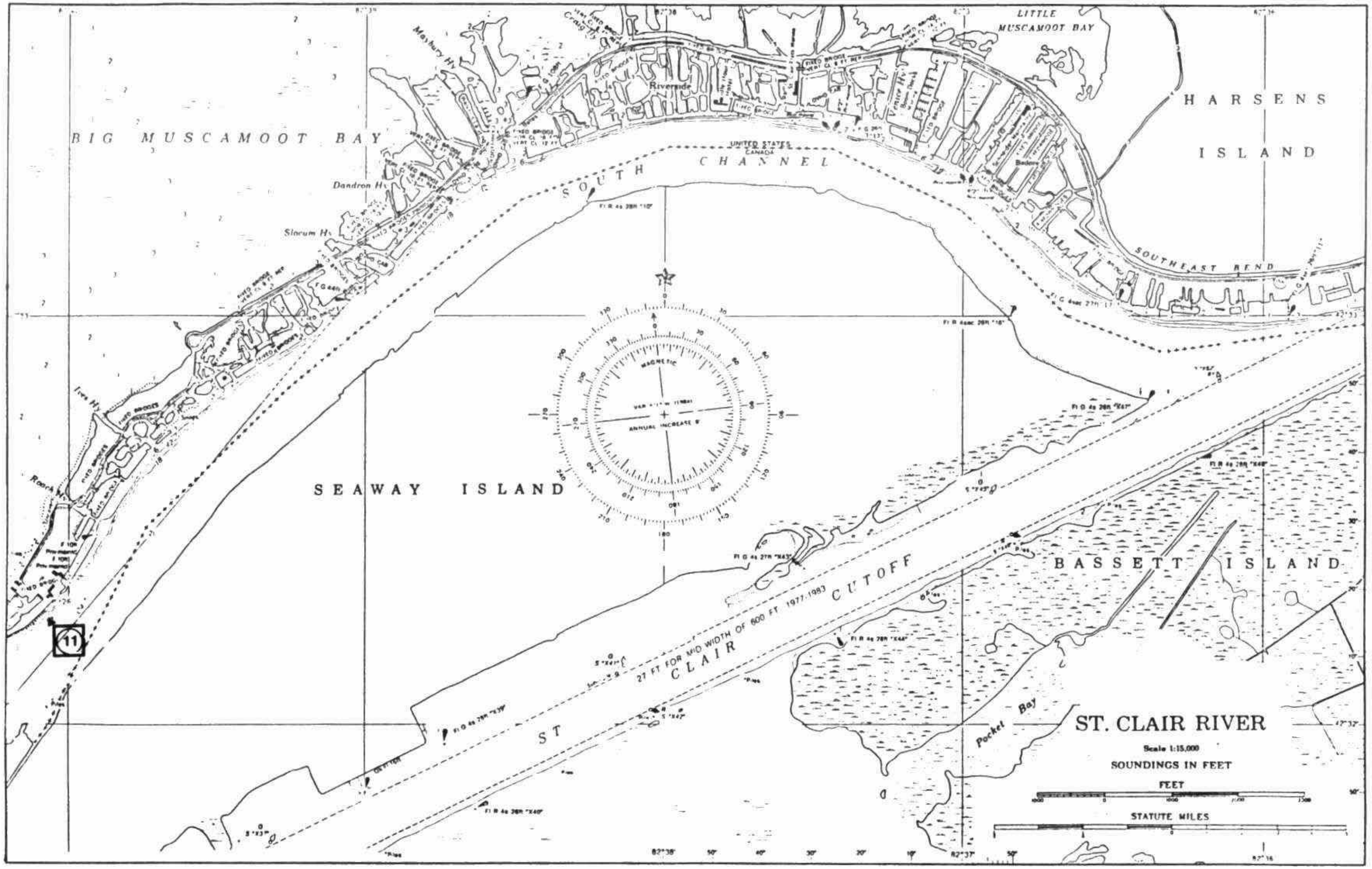

Figure 10: Location of Intake 11.

APPENDIX III:

SPILL MANUAL WORK SHEET

SPILL MANUAL WORK SHEET

(Following the steps of Parts I and II, the results may be recorded on this sheet)

SPILL IDENTIFICATION:

PART I - INPUT DATA PREPARATION:

1.(a) Outfall name: (Table I)
  (b) Water intake name: (Table II)

2.(a) Spill contaminant name:
  (b) Spill duration time: T = hr
  (c) Spill contaminant mass: M = Kg

3. Total river flow rate = cfs

PART II - SPILL IMPACT ASSESSMENT PROCEDURE:

1.	TT	=	hr	(Table III)
2.	TC	=	hr	(Table IV)
3.	TAPD	=	hr	(Table V)
4.	$\overline{DF}$			(Table VI)
5.	NUMDF	=		(Table VII)

6. Compare: T and TC :

For T < TC, only:

7. PC = ug/L (Table VIII)
8. CPC = ug/L
9. TPK = hr

10. TA = hr
11. TD = hr
12. Summarize assessment:

At time after spill start		Expected Conc.	
TA =	hr,	<CPC/20<	ug/L
TPK =	hr,	= CPC =	ug/L
TD =	hr,	<CPC/20<	ug/L

Time of Passage = TD-TA = hr

For T > TC, only:

13. EC = ug/L (Table IX)
14. CEC = ug/L
15. TPKB = hr
16. TPKE = hr
17. TA = hr
18. TD = hr
19. Summarize assessment:

At time after spill start		Expected Conc.	
TA =	hr,	<CEC/20<	ug/L
TPKB =	hr,	between these times	
TPKE =	hr,	= CEC =	ug/L
TD =	hr,	<CEC/20<	ug/L

Time of Passage = TD-TA = hr

APPENDIX IV:

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REFERENCES

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